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Common Object Library Description

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Final Report

Abstract

For Building Information Modeling (BIM) technology to be successful, it must be consistently applied across many projects, by many teams. The National Building Information Model Standard–United States (NBIMS-US) has begun to deliver standards that allow teams to consistently deliver open-standard building information. The contents of this standard describe the format and quality of information to be delivered. Software configuration guides and object templates can assist users of BIM technology to more easily meet both the format and quality requirement of NBIMS-US.

The purpose of this report is to define the requirements for and document the creation of a library of building components. The components included in this report reflect the contents of common BIM models for a duplex apartment, office building, and medical clinic building that have been previously published. This common object library description may serve as a reference for those implementing national BIM standards and for future research projects.

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Preface

This report was prepared by Kristine Fallon Associates for the US Army Engineering Research and Development Center, Construction Engineering Research Laboratory (ERDC-CERL) under the project entitled, "Life-Cycle Model for Mission Ready, Sustainable Facilities" under Contract W912HZ-09-D-0003. The technical reviewer was Dr. E. William East (CEERD-CF-N).

The work was supervised and monitored by the Engineering Processes Branch (CF-N) of the Facilities Division (CF), US Army Engineer Research and Development Center, Construction Engineering Research Laboratory (ERDC-CERL). The project manager and technical reviewer was E. William East, CEERD-CF-N. At the time of publication, Donald K. Hicks was Chief, CEERD-CF-N; L. Michael Golish was Chief, CEERD-CF; and Martin J. Savoie was the Technical Director for Installations. The Deputy Director of ERDC-CERL was Dr. Kirankumar Topudurti and the Director was Dr. Ilker Adiguzel.

CERL is an element of the US Army Engineer Research and Development Center (ERDC), US Army Corps of Engineers. The Commander and Executive Director of ERDC is COL Kevin J. Wilson, and the Director of ERDC is Dr. Jeffery P. Holland.

1   Introduction

1.1   Background

In earlier US Army Research and Development Center research, a core life-cycle Building Information Model was developed for three different buildings: a duplex apartment, an office, and a clinic. These models were developed inconsistently over time by different modelers, and they contain a variety of levels of detail and quality of content across disciplines. To perform experimental testing on building information models, it is necessary to have a consistent level of quality of each building model across all required disciplines.

1.2   Objectives

In an active design practice, the development and maintenance of an object library is often an ongoing process. New objects must be added to meet the needs of different projects or to include additional functionality with each new release of the modeling software. For the purpose of this project, the common object library is developed to include objects needed to create the 3 required building models, along with the template files needed for each design discipline. The full list of objects and the process used to create and verify the library files is documented in this report.

1.3   Approach

It is important to define the relevant standards and requirements for the model files before the project team begins modeling. This includes modeling standards, file naming conventions, and any other aspect of the model that needs to be consistent across multiple files or specified for downstream use. Before a model object can be included in the common object library or used on a project, it must be reviewed and modified to comply with the modeling standards. There may also be additional considerations that are unique to the selected modeling tools and data exchanges that need to be addressed. The standards for this project are detailed below.

1.4 Scope

The scope of this common object library report is to define the requirements for and document the creation of a library of building components to be used to create a consistent set of building models based on a common modeling standard. It will also be a reference for future modeling projects.

2   Modeling Standards

Project file names — Building model files use the following naming format:

Table 2-1: Project file name.

Project	Discipline	User Definable	Extension
PPP_	D_	U	EEE
Duplex_	A_	-	.rvt

Project — This field defines the building type:

Table 2-2: Project name.

Code	Discipline
TEMPLATE	Common object library template file
DUPLEX	Duplex apartment building
OFFICE	Office building
CLINIC	Clinic building

Discipline — This field defines the design discipline of the model. The following discipline designations will be used:

Table 2-3: Discipline abbreviations.

Code	Discipline
A	Architectural
S	Structural
M	Mechanical
E	Electrical
P	Plumbing
F	Fire Protection
MEP	MEP/FP Combined model

Common object library file names – Common object library component files will use the standard naming convention established by the object library that ships with the Revit 2011 software. The following naming format will be used:

Table 2-4: Family file names.

Units	Description	Extension
U_	D	.EEE
M_	Single Flush	.rvt

Other standards and considerations – In a traditional CAD environment, drawing layers are used to organize drawing objects and to control printed line weights, line styles, or line visibility within each cad file. Revit files do not use layers. Instead Revit includes global settings to control line weights, line styles, and object visibility based on the object category, or "Object Style". This allows the user to define the presentation of all objects based on their category, rather than relying on the use of individual layers within each separate view or drawing file. While most traditional cad standards would include layer requirements, standards based on a Revit workflow may need to address Object Styles instead.

For the purpose of this project, all objects included in the common object library will use the default object style settings.

3 COBie Properties

In order to generate a COBie deliverable directly from a Revit model, custom object properties must be added to the model to carry additional COBie data that is not available in the default Revit configuration. When the Revit model is exported to IFC format, the parameters are exported as IfcPropertySingleValue, with the Ifc property name matching the Revit parameter name.

3.1 Family Parameters and Project Parameters

When adding parameters to objects in a Revit model, the new parameters may be applied to the individual families as a family parameter or to an entire object category as a project parameter. These custom parameters can be added to the objects using default Revit commands.

- Family parameters are applied to each individual component family by editing the family RFA file directly. If the parameter is required on multiple objects or object types, each individual file will need to be edited to include the new parameter. Likewise, if a new family is added to a project, it must be updated to include the custom parameters. For example, if a generic model element is replaced with a manufacturer provided family of a specific product, the new family will need to be updated to include the required parameters.
- Project parameters are applied to entire object categories within the Revit template. When a component file is loaded into the template or project file for use, project parameters are automatically added to the component based on the object category, so there is no need to add the parameters to each individual component file.

When adding parameters that apply to entire object categories, such as those required for basic COBie data, it is best to apply them as project parameters. This will create a set of common properties that are available on all objects of the desired category, without the need to update individual files. This will ensure consistency and data integrity of the individual family files are changed.

Family parameters can be used to extend the data set for unique objects within the broad object categories when a specific subset of properties is

required. This includes object specific property fields required by the owner for FM use. For example, the owner may need to track a specific subset of properties for chillers and a different subset of properties for VAV boxes, both of which are included in the Revit object category for mechanical equipment.

For the purpose of this project, all of the baseline COBie properties have been added to the templates as project parameters.

3.2   Shared Parameters

When adding parameters to a Revit model, the new parameter can be added as a basic parameter or as a shared parameter. The designation of "shared parameter" is a method of standardizing the parameter format (naming standard and data type) across multiple files, and can apply to the parameters assigned in both the project and the family. When selecting the shared parameter option, the parameter name and settings can be defined in an external text file, allowing the same settings to be used across multiple files. In addition to ensuring consistency between files, the shared parameter option also allows the parameter to be used in tags when documenting a project.

All custom COBie data parameters have been added to the templates as shared parameters, with the exception of Category Code and Category Description, as described below. The resulting shared parameter text file *COBieSharedParameters.txt* is included with the common object library template files.

3.3   OmniClass Parameters

Revit component families include default fields for OmniClass Number and OmniClass Title, which can be set within the family file. However, Revit system families which are built into the template file (including Rooms, Walls, Roofs, etc.), do not include fields for OmniClass information.

To address this, Category Code and Category Description project parameters have been added to the Rooms and Project Information categories in the Revit template files. These parameters are used to carry the OmniClass categories for spaces (in the Rooms category) and for the building (in the Project Information category). Additionally, shared

parameters named Classification Code and Classification Description have been added to the system families to assign OmniClass data to the built in object types.

To facilitate applying the OmniClass category to the room objects, the template includes a Room Key Schedule for OmniClass Table 13. When editing the properties of a room, the OmniClass category can be selected from the *OmniClass Table 13 Category* property listed under the room's Identity Data. This will automatically fill in the Category Code and Category Description fields for the selected room. Note that these parameters are not added as shared parameters, because Revit 2011 does not allow access to shared parameters within a key schedule.

3.4   Instance Parameters and Type Parameters

Parameters can be added to Revit objects and categories as either instance parameters or type parameters. An instance parameter allows a unique input for every individual placement, or instance, of an object. A type parameter allows a single data input to be defined for all objects of the given type. All COBie properties from the Component tab, as well as any unique properties that are required on other tabs, are added as instance parameters. All COBie properties that are required on the Type tab, or are common to all instances of the same type, are added as type parameters. This setting is listed in the parameter groups defined in the *COBieSharedParameters.txt* file, and is listed in the charts in the next section.

3.5   IFC Export Override Parameters

When exporting a model to IFC format, Revit will map each object type from the model to the corresponding IFC entity type. The settings for these category mappings are edited in the IFC Export Classes dialog box, and can be saved as an external text file.

One limitation of this object category settings is that Revit object categories are defined more broadly than the corresponding IFC entities. For example, the Revit MEP category for Mechanical Equipment covers many types of equipment, including boilers, chillers, fans, etc. while the IFC entities include specific categories for IfcBoiler, IfcChiller, and IfcFan. When these objects are exported from Revit to IFC using the default

settings, all of the objects are exported based on the single category defined in the IFC Export Classes dialog box.

In order to override an individual family's IFC export category, two additional shared project parameters have been added: IfcExportAs and IfcExportType.

- **IfcExportAs:** This parameter should be filled in with a valid IFC entity type. Revit will export the object to the IFC category given in this property instead of the default setting defined in the IFC Export Classes dialog box.
- **IfcExportType:** This parameter should be filled in with the IFC Predefined Type setting.

These parameters were added to the project templates as shared project parameters available to every object type. If these parameters are left empty, then the default export settings will be used. If they are filled in, then this setting will override the default IFC export category.

See Chapter 6 of this report for a list of the families that used the IFC override settings.

4 Mapping of Revit Parameters to COBie Spreadsheet

The following charts list the COBie parameters used in the common object library template files. These parameters are exported to IFC, and are then mapped directly to a COBie spreadsheet using the BimServices Transfrom1 utility. The spreadsheet tabs that can be directly populated using the BimServices utility include: Facility, Floor, Space, Type, Component, and Attribute. Revit can also contain data required on the Zone and System tabs, but this data is not picked up by the BimServices utility or is not formatted in a way that will map directly to the tab layout. These tabs are addressed separately below. Data recorded on the remaining tabs are not generally available in a design-phase Revit model.

4.1 Facility Tab

Table 4-1: Facility tab parameters.

Facility Tab Parameters					
COBie Sheet / Field	Revit Property (Default)	Revit Property (Custom)	Rooms (Instance)	Project Information	Project Units
Name	See note 1				
CreatedBy	Revit Username				
CreatedOn	See note 2				
Category		Category Code	X	X	
Category		Category Description	X	X	
ProjectName	Project Number			X	
SiteName	Exported as "Default"				
LinearUnits	Project Units: Length				X
AreaUnits	See Note 2				X
VolumeUnits	See Note 2				X
CurrencyUnits	Not exported				X

Facility Tab Parameters					
COBie Sheet / Field	Revit Property (Default)	Revit Property (Custom)	Rooms (Instance)	Project Information	Project Units
AreaMeasurement	See note 3				
ExtSystem	IfcApplication				
ExtObject	By object type				
ExtIdentifier	Element Guid				
ExtSiteObject	IfcSite				
ExtSiteIdentifier	Guid				
ExtFacilityObject	IfcBuilding				
ExtFacilityIdentifier	Guid				
Description	Not exported				
ProjectDescription	Not exported				
SiteDescription	Exported as "Default"				
Phase	Project Status			X	

Notes:

1. The project name is available in the IFC file, but the field is not picked up by the BimServices Transform1 utility when generating the COBie file.
2. Length, area, volume and other units can be set in the Revit project file using the Project Units command, and these fields are populated by the BimServices Transform1 utility according to these settings. However, when Revit exports actual area and volume to IFC, it uses the Length unit setting as the default to calculate area and volume, regardless of the internal settings for area or volume. Length, area, and volume settings within Revit should be set to use the same base unit to maintain consistency.
3. Revit exports room area to IFC format using the project settings for Area and Volume Computations. By default, this is set to Wall Center, but it can also be set to Wall Finish, Wall Core Layer, or Wall Core Center. Revit does not list the area settings in the IFC export, but it lists GSA BIM Area as the area scheme.

4.2   Floor Tab

Table 4-2: Floor tab parameters.

Floor Tab Parameters			
COBie Sheet / Field	**Revit Property (Default)**	**Revit Property (Custom)**	**Levels (Instance)**
Name	Level Name		X
CreatedBy	Revit Username		
CreatedOn	See note 1		
Category		Category	X
ExtSystem	IfcApplication		
ExtObject	By object type		
ExtIdentifier	Element Guid		
Description	Level Name		
Elevation	Elevation		X
Height	N/A		

Notes:

1. This field is populated by the BimServices Transform1 utility when the COBie file is generated, and is not based on a Revit property.

4.3   Space Tab

Table 4-3: Space tab parameters.

COBie Sheet / Field	Revit Property (Default)	Revit Property (Custom)	Rooms (Instance)
Space Tab Parameters			
Name	Room Number		X
CreatedBy	Revit Username		
CreatedOn	See note 1		
Category		Category Code	X
Category		Category Description	X
FloorName	Level: Name		X
Description	Room Name		X
ExtSystem	IfcApplication		
ExtObject	By object type		
ExtIdentifier	Element Guid		
Room Tag	N/A		
UsableHeight	Unconnected Height		X
GrossArea	Area		X
NetArea	N/A		X

Notes:

1. This field is populated by the BimServices Transform1 utility when the COBie file is generated, and is not based on a Revit property.

4.4 Type Tab

Table 4-4: Type tab parameters.

Type Tab Parameters			
COBie Sheet / Field	Revit Property (Default)	Revit Property (Custom)	All Components (Type)*
Name	Family Type		X
CreatedBy	Revit Username		
CreatedOn	See note 1		
Category	OmniClass Number	See Note 2	X
Category	OmniClass Title	See note 2	X
Description	Family Type		X
AssetType		AssetAccountingType	X
Manufacturer	Manufacturer		X
ModelNumber		ModelNumber	X
WarrantyGuarantorParts		WarrantyGuarantorParts	X
WarrantyDurationParts		WarrantyDurationParts	X
WarrantyGuarantorLabor		WarrantyGuarantorLabor	X
WarrantyDurationLabor		WarrantyDurationLabor	X
ExtSystem	IfcApplication		
ExtObject	By object type		
ExtIdentifier	Element Guid		
ReplacementCost		ReplacementCost	X
ExpectedLife		ExpectedLife	X
DurationUnit		DurationUnit	X
WarrantyDescription		WarrantyDescription	X
NominalLength		NominalLength	X
NominalWidth		NominalWidth	X
NominalHeight		NominalHeight	X
ModelReference		ModelReference	X

Type Tab Parameters			
COBie Sheet / Field	Revit Property (Default)	Revit Property (Custom)	All Components (Type)*
Shape		Shape	X
Size		Size	X
Color		Color	X
Finish		Finish	X
Grade		Grade	X
Material		Material	X
Constituents		Constituents	X
Features		Features	X
AccessibilityPerformance		AccessibilityPerformance	X
CodePerformance		CodePerformance	X
SustainabilityPerformance		SustainabilityPerformance	X

Notes:

1. This field is populated by the BimServices Transform1 utility when the COBie file is generated, and is not based on a Revit property.
2. OmniClass Number and OmniClass Title are default parameters available in Revit component families, but are not available on all system families.

4.5   Component Tab

Table 4-5: Component tab parameters.

Component Tab Parameters			
COBie Field	Revit Property (Default)	Revit Property (Custom)	All Components (Instance)
Name	See note 1		X
CreatedBy	Revit Username		
CreatedOn	See note 2		
TypeName	Family Type		X
Space	Room: Name		X
Description	See note 1		
ExtSystem	IfcApplication		
ExtObject	By object type		
ExtIdentifier	Element Guid		
SerialNumber		SerialNumber	X
InstallationDate		InstallationDate	X
WarrantyStartDate		WarrantyStartDate	X
TagNumber		TagNumber	X
BarCode		BarCode	X
AssetIdentifier		AssetIdentifier	X

Notes:

1. Element Name is exported to IFC as a compound field composed of the following Revit fields: Family: Family Type: Element ID.
2. This field is populated by the BimServices Transform1 utility when the COBie file is generated, and is not based on a Revit property.

4.6   Attribute Tab

Any additional parameters from Revit families are included on the
Attribute tab. The available parameters will vary by Revit family and object
type, but the following properties are included at a minimum to address
COBie Attribute tab fields for each object type.

Table 4-6: Attribute tab parameters.

Attribute Tab Parameters						
Revit Property (Default)	Revit Property (Custom)	All Components (Type)	Doors (Type)	Windows (Type)	Rooms (Instance)	Furniture (Type)
	Reference	X				
	ArticleNumber	X				
	ProductionYear	X				
Construction Type			X	X		
	OperationType		X	X		
	Area		X	X		X
Fire Rating			X			
	GlazingAreaFraction		X	X		
	IsFireExit		X			
	ConfigurationType			X		
	FireRating			X		
	FloorCovering				X	
	CeilingCovering				X	
	WallCovering				X	
	LoadCapacity				X	

4.7   Zone Tab

The Zone tab in the COBie spreadsheet is used to group Spaces together
based on common function, use, or other requirements. Default Zone

types include Circulation Zone, Lighting Zone, Fire Alarm Zone, Historical Preservation Zone, Occupancy Zone, and Ventilation Zone, which are defined on the PickList tab of the COBie spreadsheet. Revit MEP includes an HVAC Zone tool which allows the MEP designer to group spaces together for the purpose of designing the mechanical systems. This information would correspond to the Ventilation Zone type on the COBie Zone tab. However, Revit does not export HVAC Zone data to IFC, and BimServices does not populate this tab from the IFC model.

To address the requirements of the Zone tab, a series of project parameters have been added to Rooms in the Revit template files to assign each room to each zone type. These parameters will export to IFC as IfcPropertySingleValue, and will be picked up by the BimServices Transfrom1 utility on the Attribute tab. These properties can be used as a reference to manually populate the Zone tab. If additional zones are required on a project, additional properties must be added to the Rooms category using the Project Parameters command.

Table 4-7: Zone tab parameters.

Zone Tab Parameters		
COBie Zone Type	Revit Property (Custom)	Rooms (Instance)
Circulation Zone	CirculationZoneName	X
Lighting Zone	LightingZoneName	X
Fire Alarm Zone	FireAlarmZoneName	X
Historical Preservation Zone	HistoricalPreservationZoneName	X
Occupancy Zone	OccupancyZoneName	X
Ventilation Zone	VentilationZoneName	X

4.8 System Tab

The System tab in the COBie spreadsheet is used to group components into building systems. Revit MEP includes systems for mechanical, piping, and electrical elements, allowing the user to create multiple systems within each category.

When exporting a model to IFC, Revit will include properties on the MEP elements for System Type and System Name, which list the system(s) that each item is associated with. These properties will be picked up by the BimServices Transform1 utility on the Attribute tab. These properties can be used as a reference to manually populate the System tab.

5   Common Object Library Files

The common object library files were selected from free publicly available sources or created specifically for use on this project. Model objects were collected or created for use in Revit Architecture 2011 and Revit MEP 2011, from the following sources in order of preference:

- **Revit 2011 Content Library:** Most objects can be taken directly from the default content library that is installed with Revit 2011 products.
- **Free online libraries:** Objects not available in the default library can often be found online at websites dedicated to the model authoring tools. In this case, the primary online source was www.seek.autodesk.com, a content search engine that allows users to search for content from multiple online sources for use in AutoDesk software such as Revit.
- **Custom creation:** If the required objects were not available in a free public library, they were created in Revit Architecture 2011 or Revit MEP 2011 for use on this project.

Model content within Revit can be grouped into two broad categories:

- **Component families** are elements that are placed individually and can be created and saved as external files. They include building objects such as doors, windows, furniture, etc. Component families are saved as individual files in the Revit .rfa file format, and are provided as individual files in the common object library.
- **System families** are elements that are defined within the Revit interface to serve a specific purpose as part of the building such as walls, floors, and roofs. System families are built into the Revit interface and cannot be saved as separate files. These families are included in the discipline templates provided in the Revit .rte file format.

The common object library families and the source for each are given in the tables below.

5.1   Revit Component Families

Table 5-1: Component family file names.

Revit Component Families: Air Terminals		
Family File Name	**Source**	**Comments**
M_Louver - Extruded.rfa	MEP Library	
M_Return Diffuser.rfa	MEP Library	
M_Supply Diffuser – Sidewall.rfa	MEP Library	
M_Supply Diffuser.rfa	MEP Library	
Revit Component Families: Casework		
Family File Name	**Source**	**Comments**
M_Base Cabinet-Double Door & 2 Drawer.rfa	Arch Library	
M_Counter Top w Sink Hole.rfa	Arch Library	
M_Counter Top.rfa	Arch Library	
M_Counter Top-L Shaped.rfa	Arch Library	
M_Tall Cabinet-Single Door(2).rfa	Arch Library	
M_Upper Cabinet-Double Door-Wall.rfa	Arch Library	
M_Upper Cabinet-Single Door-Wall.rfa	Arch Library	
M_Vanity Cabinet-Double Door Sink Unit.rfa	Arch Library	
M_Vanity Counter Top w Round Sink Hole.rfa	Arch Library	
Revit Component Families: Data Devices		
Family File Name	Source	Comments
M_Data Outlet.rfa	MEP Library	
M_Ethernet Switch.rfa	MEP Library	
Revit Component Families: Doors		
Family File Name	Source	Comments
M_Curtain Wall Dbl Chain Link.rfa	Custom	
M_Curtain Wall Dbl Glass.rfa	Arch Library	
M_Curtain Wall Sgl Glass.rfa	Arch Library	
M_Double-Flush.rfa	Arch Library	
M_Double-Glass 1.rfa	Arch Library	
M_Roof Hatch.rfa	Autodesk Seek	
M_Single-Flush.rfa	Arch Library	

M_Single-Glass 1.rfa	Arch Library	
M_Toilet Partition.rfa	Custom	

Revit Component Families: Electrical Equipment		
Family File Name	Source	Comments
M_Diesel Emergency Power Generator.rfa	MEP Library	
M_Lighting and Appliance Panelboard - 208V MLO.rfa	MEP Library	
M_Transformer Switchboard.rfa	MEP Library	

Revit Component Families: Electrical Fixtures		
Family File Name	**Source**	**Comments**
M_Elevator Door-Center.rfa	Autodesk Seek	
M_Elevator-Hydraulic.rfa	Autodesk Seek	
M_Junction Boxes - Load.rfa	MEP Library	
M_Duplex Receptacle.rfa	MEP Library	
M_Microwave.rfa	MEP Library	
M_Range.rfa	Arch Library	
M_Refrigerator.rfa	MEP Library	
M_Lighting Switches.rfa	MEP Library	
M_Thermostat.rfa	MEP Library	

Revit Component Families: Fire Alarm Devices		
Family File Name	**Source**	**Comments**
M_Fire Alarm Control Panel.rfa	MEP Library	
M_Fire Alarm Strobe Speaker - Wall Mounted.rfa	MEP Library	
M_Manual Pull Station.rfa	MEP Library	
M_Smoke Detector.rfa	MEP Library	

Revit Component Families: Furniture		
Family File Name	**Source**	**Comments**
M_Bed-Standard.rfa	Arch Library	
M_Chair-Corbu.rfa	Arch Library	
M_Marker Board.rfa	Autodesk Seek	
M_Shelving.rfa	Arch Library	
M_Sofa.rfa	Arch Library	
M_Table-Coffee.rfa	Arch Library	

Revit Component Families: Lighting Fixtures		

Family File Name	Source	Comments
M_Ceiling Light - Flat Round.rfa	MEP Library	
M_Downlight - Recessed Can.rfa	MEP Library	
M_Exit Sign.rfa	MEP Library	
M_Pendant Light - Hemisphere.rfa	MEP Library	
M_Pendant Light - Linear - 2 Lamp.rfa	MEP Library	
M_Plain Recessed Lighting Fixture.rfa	MEP Library	
M_Sconce Light - Sphere.rfa	MEP Library	
M_Troffer Light - Lens.rfa	MEP Library	
Revit Component Families: Mechanical Equipment		
Family File Name	**Source**	**Comments**
M_Air Handling Unit - Split System - Horizontal.rfa	MEP Library	
M_Air Handling Unit-Vertical Packaged-DX-21-35 kW.rfa	MEP Library	
M_Centrifugal Fan - Rooftop - Upblast.rfa	MEP Library	
M_Hot Water Boiler - 59-440 kW.rfa	MEP Library	
M_Inline Pump - Circulator.rfa	MEP Library	
M_Radiator - Hydronic Fin Tube.rfa	MEP Library	
M_Screw Chiller - Air Cooled - 1406-1758 kW.rfa	MEP Library	
M_Sewage Pump - Vertical Discharge.rfa	MEP Library	
M_VAV Unit - Single Duct.rfa	MEP Library	
M_Water Heater.rfa	MEP Library	
Revit Component Families: Plumbing Fixtures		
Family File Name	**Source**	**Comments**
M_ADA shower Seat.rfa	Autodesk Seek	
M_Backflow Preventer - 15-50 mm.rfa	MEP Library	
M_Ball Valve - 50-150 mm.rfa	MEP Library	
M_Bath Tub.rfa	MEP Library	
M_Cleanout Two-Way - PVC - Sch 40 - DWV.rfa	MEP Library	
M_Drinking Fountain - Rectangular - Wall Mounted.rfa	MEP Library	
M_Fire Extinguisher Cabinet.rfa	MEP Library	
M_Floor Drain - Round.rfa	MEP Library	
M_Grab Bars.rfa	Autodesk Seek	
M_Hand Dryer.rfa	MEP Library	

M_Kitchen Unit.rfa	MEP Library	
M_Lavatory - Oval.rfa	MEP Library	
M_Mirror.rfa	Autodesk Seek	
M_Roof Drain.rfa	MEP Library	
M_Shower Stall - Rectangular.rfa	MEP Library	
M_Sink - Island - Single.rfa	MEP Library	
M_Sink - Kitchen - Double.rfa	MEP Library	
M_Sink - Work.rfa	MEP Library	
M_Soap Dispenser.rfa	Autodesk Seek	
M_Toilet Paper Holder.rfa	Autodesk Seek	
M_Towel Dispensers - receptical.rfa	Autodesk Seek	
M_Towel Dispensers.rfa	Autodesk Seek	
M_Urinal - Wall Hung.rfa	MEP Library	
M_Water Closet - Flush Tank.rfa	MEP Library	
M_Water Closet - Flush Valve - Wall Mounted.rfa	MEP Library	
Revit Component Families: Sprinklers		
Family File Name	**Source**	**Comments**
M_Sprinkler - Horizontal Sidewall.rfa	MEP Library	
M_Sprinkler - Pendent.rfa	MEP Library	
Revit Component Families: Structural Columns		
Family File Name	**Source**	**Comments**
M_Concrete-Rectangular-Column.rfa	Arch Library	
M_W-Wide Flange-Column.rfa	Arch Library	See note 1
Revit Component Families: Structural Foundations		
Family File Name	**Source**	**Comments**
M_Footing-Rectangular.rfa	**Arch Library**	
Revit Component Families: Structural Framing		
Family File Name	**Source**	**Comments**
M_K-Series Bar Joist-Rod Web.rfa	Arch Library	See note 1
M_Plywood Web Joist.rfa	Arch Library	
M_W-Wide Flange.rfa	Arch Library	See note 1
Revit Component Families: Telephone Devices		
Family File Name	**Source**	**Comments**

M_Telephone Outlet.rfa	MEP Library	
M_Telephone Terminal Board.rfa	MEP Library	
Revit Component Families: Windows		
Family File Name	**Source**	**Comments**
M_Casement.rfa	Custom	
M_Fixed.rfa	Arch Library	
M_Skylight.rfa	Arch Library	

Notes:

1. This object type is available in a wide range of sizes. Rather than create all of the different types in the main RFA file, Revit allows the individual types to be defined in an external TXT file called a *type catalog*, to allow the user to select the desired sizes without loading every possible type. The type catalog must be saved in the same directory as the associated RFA file and have the same file name. The type catalog file is included in the common object library.

5.2 Revit System Families

System families are contained within the Revit templates. Many of these objects are not treated as assets by the BimServices Transform1 utilty, but are included in the common object library as individual IFC exports. The system families used and their host templates are listed below.

Table 5-2: System family names.

Revit System Families: Cable Trays		
Family File Name	**Source**	**Comments**
Cable Tray with Fittings Wire mesh Cable Tray	TEMPLATE_E.rte	
Revit System Families: Ceilings		
Family File Name	**Source**	**Comments**
Compound Ceiling ACT 600 x 600mm Grid	TEMPLATE_A.rte	
Compound Ceiling Gypsum Board	TEMPLATE_A.rte	
Revit System Families: Conduits		
Family File Name	**Source**	**Comments**
Data	TEMPLATE_E.rte	
Electrical Metallic Tubing (EMT)	TEMPLATE_E.rte	

Revit System Families: Ducts		
Family File Name	**Source**	**Comments**
Rectangular Duct Mitered Elbows - Taps	TEMPLATE_M.rte	
Rectangular Duct Mitered Elbows - Tees	TEMPLATE_M.rte	
Round Duct - Taps	TEMPLATE_M.rte	
Round Duct - Tees	TEMPLATE_M.rte	
Revit System Families: Flex Ducts		
Family File Name	**Source**	**Comments**
Flex - Round.ifc	TEMPLATE_M.rte	
Revit System Families: Floors		
Family File Name	**Source**	**Comments**
66mm Concrete With 38mm Metal Deck	TEMPLATE_A.rte	
127mm Slab on Grade	TEMPLATE_A.rte	
150mm Exterior Slab on Grade	TEMPLATE_A.rte	
150mm Slab on Grade	TEMPLATE_A.rte	
Finish Floor - Ceramic Tile	TEMPLATE_A.rte	
Finish Floor - Slate Tile	TEMPLATE_A.rte	
Finish Floor - VCT	TEMPLATE_A.rte	
Finish Floor - Wood	TEMPLATE_A.rte	
Residential - Wood Joist with Subflooring	TEMPLATE_A.rte	
Revit System Families: Pipes		
Family File Name	**Source**	**Comments**
Cold Water	TEMPLATE_P.rte	
Fire Protection	TEMPLATE_P.rte	
Hot Water	TEMPLATE_P.rte	
Storm	TEMPLATE_P.rte	
Vent	TEMPLATE_P.rte	
Waste	TEMPLATE_P.rte	
Revit System Families: Railings		
Family File Name	**Source**	**Comments**
900mm Handrail Only	TEMPLATE_A.rte	
900mm Pipe Guard Rail	TEMPLATE_A.rte	
1100mm Guard Rail	TEMPLATE_A.rte	

Revit System Families: Ramps		
Family File Name	**Source**	**Comments**
150mm Concrete ADA Ramp	TEMPLATE_A.rte	
Revit System Families: Roofs		
Family File Name	**Source**	**Comments**
EPDM Membrane on Rigid Insul on Metal Deck	TEMPLATE_A.rte	
Exterior Canopy	TEMPLATE_A.rte	
Live Roof over Wood Joist Flat Roof	TEMPLATE_A.rte	
Standing Seam Metal Roof	TEMPLATE_A.rte	
Revit System Families: Stairs		
Family File Name	**Source**	**Comments**
Concrete Pan - 180mm Max Riser 280mm Tread	TEMPLATE_A.rte	
Monolithic Concrete Stair	TEMPLATE_A.rte	
Residential - 200mm Max Riser 250mm Tread	TEMPLATE_A.rte	
Revit System Families: Structural Foundations		
Family File Name	**Source**	**Comments**
Bearing Footing - 900 x 300	TEMPLATE_A.rte	
Retaining Footing - 600 x 300 x 300	TEMPLATE_A.rte	
Revit System Families: Walls		
Family File Name	**Source**	**Comments**
Exterior - Brick on Brick	TEMPLATE_A.rte	
Exterior - Brick on Mtl Stud	TEMPLATE_A.rte	
Exterior - Insul Panel on Mtl Stud	TEMPLATE_A.rte	
Foundation - Concrete (264mm)	TEMPLATE_A.rte	
Foundation - Concrete (300mm)	TEMPLATE_A.rte	
Foundation - Concrete (350mm)	TEMPLATE_A.rte	
Foundation - Concrete (417mm)	TEMPLATE_A.rte	
Foundation - Concrete (550mm)	TEMPLATE_A.rte	
Interior - CMU Rated 2-HR	TEMPLATE_A.rte	
Interior - Furring (38 mm Stud)	TEMPLATE_A.rte	
Interior - Furring (152 mm Stud)	TEMPLATE_A.rte	
interior - Partition (92mm Stud)	TEMPLATE_A.rte	
Interior - Plumbing (152mm Stud)	TEMPLATE_A.rte	

Interior - Rated 1-HR (92mm Stud)	TEMPLATE_A.rte	
Interior - Toilet Partition (25mm)	TEMPLATE_A.rte	
Party Wall - CMU Residential Unit Demising Wall	TEMPLATE_A.rte	
Retaining - Concrete (300mm)	TEMPLATE_A.rte	
Storefront	TEMPLATE_A.rte	Curtain Wall

5.3 Revit Template Files

Table 5-3: Revit template file names.

Revit Template Files		
Template File Name	Discipline	Comments
TEMPLATE_A.rte	Architectural	Includes Structural
TEMPLATE_M.rte	Mechanical	
TEMPLATE_E.rte	Electrical	
TEMPLATE_P.rte	Plumbing	Includes Fire Protection
TEMPLATE_MEP.rte	MEP	Combined template
COBieSharedParameters.txt		Parameters file
IFC-exportlayers.txt		IFC Export settings

6   IFC File Export

Common object library files are provided in their native Revit format, along with an IFC export of each family and the COBie spreadsheet created from each IFC file.

To create each individual IFC file, each Revit family is placed into an empty Revit project. If the family is a hosted object, such as a door that is hosted by a wall, then the required host object must be drawn first, with the family placed on the host element.

In order for each of the custom data parameters to export to IFC, each parameter must be filled in. A custom API routine was written to fill each parameter with text reporting the parameter name. In a live project, this data would be filled in with the appropriate COBie data instead.

IFC files of each family were exported from Revit using the Revit Application Menu > Export > IFC command.

6.1   IFC Export Settings

When exporting to IFC, Revit includes settings to map object categories to IFC entities. The default mappings are focused mainly on architectural elements, while many of the MEP elements are set to export as IfcBuildingElementProxy entities by default. These proxy entities do not include full object type information, and should be mapped to the correct IFC entity categories instead. The export settings are saved as an external TXT file, which is included in the common object library templates directory named *IFC-exportlayers.txt*.

6.2   IFC Export Override

In addition to the IFC export category mappings, some of the families required IFC export override parameters to map the Revit family to a specific IFC category, as described in Chapter 3 of this report. The families that used the override settings, and the IFC categories that were used, are given in the following chart.

Table 6-1: IFC export override parameter settings.

IFC Export Override Parameter Settings		
Revit Family	IfcExportAs	IfcExportType
M_Air Handling Unit - Split System - Horizontal.rfa	IfcFanType	CENTRIFUGALAIRFOIL
M_Air Handling Unit - Vertical Packaged - DX - 21-35 kW.rfa	IfcFanType	CENTRIFUGALAIRFOIL
M_Bath Tub.rfa	IfcSanitaryTerminalType	BATH
M_Centrifugal Fan - Rooftop - Upblast.rfa	IfcFanType	CENTRIFUGALAIRFOIL
M_Drinking Fountain - Rectangular - Wall Mounted.rfa	IfcSanitaryTerminalType	SANITARYFOUNTAIN
M_Duplex Receptacle.rfa	IfcOutletType	POWEROUTLET
M_Fire Alarm Control Panel.rfa	IfcElectricDistributionPoint	CONTROLPANEL
M_Floor Drain - Round.rfa	IfcPipeFittingType	ENTRY
M_Hot Water Boiler - 59-440 kW.rfa	IfcBoilerType	WATER
M_Inline Pump - Circulator.rfa	IfcPumpType	CIRCULATOR
M_Lavatory - Oval.rfa	IfcSanitaryTerminalType	SINK
M_Lighting and Appliance Panelboard - 208V MLO.rfa	IfcElectricDistributionPoint	DISTRIBUTIONBOARD
M_Microwave.rfa	IfcElectricApplianceType	MICROWAVE
M_Radiator - Hydronic Fin Tube.rfa	IfcHeatExchangerType	SHELLANDTUBE
M_Range.rfa	IfcElectricApplianceType	ELECTRICCOOKER
M_Refrigerator.rfa	IfcElectricApplianceType	FRIDGE_FREEZER
M_Roof Drain.rfa	IfcPipeFittingType	ENTRY
M_Screw Chiller - Air Cooled - 1406-1758 kW.rfa	IfcChillerType	AIRCOOL
M_Screw Chiller - Air Cooled - 281-1231 kW.rfa	IfcChillerType	AIRCOOL

M_Shower Stall - Rectangular.rfa	IfcSanitaryTerminalType	SHOWER
M_Sink - Island - Single.rfa	IfcSanitaryTerminalType	SINK
M_Sink - Kitchen - Double.rfa	IfcSanitaryTerminalType	SINK
M_Sink - Work.rfa	IfcSanitaryTerminalType	SINK
M_Telephone Terminal Board.rfa	IfcElectricDistributionPoint	DISTRIBUTIONBOARD
M_Thermostat.rfa	IfcControllerType	TWOPOSITION
M_Transformer Switchboard.rfa	IfcTransformerType	VOLTAGE
M_Urinal - Wall Hung.rfa	IfcSanitaryTerminalType	URINAL
M_VAV Unit - Single Duct.rfa	IfcFanType	NOTDEFINED
M_Water Closet - Flush Tank.rfa	IfcSanitaryTerminalType	WCSEAT
M_Water Closet - Flush Valve - Wall Mounted.rfa	IfcSanitaryTerminalType	WCSEAT
M_Water Heater.rfa	IfcTankType	PREFORMED

7 COBie File Conversion

Once the IFC files have been exported from Revit, they are translated to COBie format using the BimServices Transform1 utility along with the *_asCOBIE2.xml.xsl* file (dated 04/06/2011). This tool will generate an IFCxml file and a COBie 2.40 spreadsheet from the IFC file.

Each COBie spreadsheet should contain one Component tab entry and one Type tab entry for the object from the IFC file. In the case of hosted elements (such as doors and windows), there is also be an entry for the host element. The BimServices utility also populates the Attribute tab with additional object data, along the Contact, Facility, and Level tab for each of the files.

Each of the COBie spreadsheets was manually checked to verify that the Type and Component tabs had been correctly filled in. While most of the files were correctly translated to the COBie spreadsheet, there were a few exceptions, as noted below.

Object category not exported from Revit: Using the default IFC export settings, two of the Revit categories did not export to IFC correctly. The default Revit setting used an invalid IFC entity category, which was then skipped during the export process. To correct this, the export settings were revised to use valid IFC categories, and re-exported. The Revit categories and relevant settings are listed below. The updated settings are included in the *IFC-exportlayers.txt* file in the common object library Templates directory.

Table 7-1: IFC export categories.

Revit Category	Default Setting	Revised Setting
Cable Trays	IFCCableTraySegment	IfcCableCarrierSegment
Cable Tray Fittings	IFCCableTrayFitting	IfcCableCarrierSegmentFitting
Conduits	IFCConduitSegment	IfcCableSegment
Conduit Fittings	IFCConduitFitting	IfcCableSegment

Component tab entry with no Type tab entry: Some object categories produced COBie spreadsheet files that included a Component tab entry with no corresponding Type tab entry. The categories included system family elements that are generally large assemblies or parts of the building such as walls, floors, and roofs. These objects are typically not required as COBie assets, and are ignored by the BimServices Transform1 utility unless a command line switch is used to include all objects in the IFC file is used (using the "all=yes" switch in the command line, as noted in the program's documentation). The Revit categories and the IFC export settings are given below, along with a note indicating whether the category is treated as an asset by the BimServices utility. This project will use the "all=yes" switch to include these objects in the COBie files.

Table 7-2: Component families with no COBie type.

Revit Category	Export Category	BimServices Asset
Ceiling	IfcCovering	Yes
Floor	IfcSlab	No
Generic Model	IfcBuildingElementProxy	See below
Railing	IfcRailing	No
Ramp	IfcRamp	No
Roof	IfcRoof	No
Specialty Equipment	IfcBuildingElementProxy	See below
Stair	IfcStair	No
Structural Foundation	IfcFooting	No
Structural Framing	IfcBeam	No
Wall	IfcWall	No

The Revit object categories for Generic Models and Specialty Equipment are very broad categories that cover many different building products and components. For example, Specialty Equipment families can include site furnishings, conveying equipment, toilet specialties, and many other product categories that are typically included as COBie assets. Using the default IFC export settings, these categories will export as IfcBuildingElementProxy entities, a generic IFC entity category. When BimServices creates the COBie spreadsheet from the IFC file, IfcBuildingElementProxy objects are picked up on the Component tab, but not on the Type tab.

To avoid creating unreferenced entries on the Component tab, the Revit categories for Generic Models and Specialty Equipment are not used in the common object library. Any family selected from one of these categories must be modified by opening the file in Revit and using the Family Category and Parameters command to change the object category. Note that this will change the object category in the Revit project file, possibly affecting functionality such as schedules and graphic display. This will also change the IFC export category, but will not affect the OmniClass category setting. The common object library files that have been changed from their original category settings are listed below.

Table 7-3: Component families with modified category settings.

Revit Family	Default Category	Revised Category
M_ADA shower Seat.rfa	Specialty Equipment	Plumbing Fixtures
M_Range.rfa	Specialty Equipment	Electrical Fixtures
M_Elevator Door-Center.rfa	Specialty Equipment	Electrical Fixtures
M_Elevator-Hydraulic.rfa	Specialty Equipment	Electrical Fixtures
M_Exit Sign.rfa	Specialty Equipment	Lighting Fixtures
M_Fire Extinguisher Cabinet.rfa	Specialty Equipment	Plumbing Fixtures
M_Grab Bars.rfa	Specialty Equipment	Plumbing Fixtures
M_Hand Dryer,rfa	Specialty Equipment	Plumbing Fixtures
M_Marker Board.rfa	Specialty Equipment	Furniture
M_Microwave.rfa	Specialty Equipment	Electrical Fixtures
M_Mirror.rfa	Specialty Equipment	Plumbing Fixtures
M_Refrigerator.rfa	Specialty Equipment	Electrical Fixtures
M_Roof Hatch.rfa	Generic Models	Doors
M_Soap Dispenser.rfa	Specialty Equipment	Plumbing Fixtures
M_Toilet Paper Holder.rfa	Specialty Equipment	Plumbing Fixtures
M_Towel Dispensers–receptical.rfa	Specialty Equipment	Plumbing Fixtures
M_Towel Dispensers.rfa	Specialty Equipment	Plumbing Fixtures

Note that in some cases, the revised category may be less appropriate than the original Specialty Equipment category. The revised categories were selected as the most appropriate alternative, given the limitations on how the model objects are defined and used. For example, the *M_Hand Dryer.rfa* family might be considered an Electrical Fixture. However, in live projects this item is typically included with toilet specialties, and is

listed above as a Plumbing Fixture so that it will schedule and display with other toilet specialties in the project.

Curtain wall: Curtain wall elements in Revit are a unique object type. The curtain wall element is a container object that hosts the associated curtain panels and mullions. Each of these three object types is exported to IFC as listed in the chart below.

Table 7-4: Curtain wall IFC categories.

Revit Category	Export Category	Ifc Subcategory
Curtain Wall	IfcCurtainWall	IfcCurtainWall
Curtain Panels	IfcCurtainWall	IfcPlate
Curtain Wall Mullions	IfcCurtainWall	IfcMember

Note that Curtain Panels and Curtain Wall Mullions are exported as IfcPlate and IfcMember subparts of the IfcCurtainWall container element defined in the Revit export settings.

When curtain wall objects are translated to COBie using the BimServices Transform1 utility, the resulting COBie file does not include proper type relationships for the curtain wall objects. The IfcCurtainWall instance is picked up on the Component tab, but there is no corresponding type on the Type tab. The IfcPlate and IfcMember types and component entries are translated correctly. A review of the original IFC file shows that the IfcPlate and IfcMember entities include both instances and types, but there is no type defined for the IfcCurtainWall entity.

It should be noted that the curtain wall element itself is primarily a container element. The curtain mullions and curtain panels define the geometry and attributes of the actual model elements or building assets. The curtain wall element in Revit is a modeling convention to simplify model creation. As such, it could be considered a software artifact and ignored without losing any relevant data in the resulting COBie file.

Duplicate property data: The COBie spreadsheets produced by the BimServices Transform1 utility include a number of fields that report the IFC property data multiple times. The affected COBie fields are listed in the table below.

Table 7-5: BimServices duplicate data fields.

COBie Tab	COBie Field	Comments
Facility	Category	
Floor	Height	Lists a Boolean value (True/False) twice
Space	Category	
Space	UsableHeight	
Type	CodePerformance	Reports any property with "code' in the name
Component	InstallationDate	
Component	WarrantyStartDate	
Component	TagNumber	
Component	BarCode	
Component	AssetIdentifier	

8   COBie File Issues Review

After creating a COBie file from the IFC export, the COBie files were tested using the BimServices Transform1 utility to convert the COBie file back to IFC using the *_fromCOBIE2.ifcxml.xsl* file (dated 04/06/2011) and the *_Issues.xhtml.xsl* file (dated 01/06/2010). This process reviews the COBie file and creates an Issues report in XHTML file format. These results are included with the common object library files. With a few notable exceptions listed below, all of the tested files reported Compliance or Adequate Compliance in the issues report.

There were some object types that did not process correctly when running the *_Issues.xhtml.xsl* tool. These objects produced an error in the command line utility, and the Issues tool was aborted without completing the report. This resulted in the creation of an empty XHTML report.

This error occurred in any tested file that included one of the listed elements, including any families that are hosted by these elements or any tested building models that included these objects. The error occurred regardless of whether the elements were included in the COBie file using the "all=yes" command line switch. The common object library files for these objects are listed in the table below.

Table 8-1: Files not processed by BimServices issues check.

Files not Processed by BimServices Issues Check		
IFC File Name	Category	Comments
EPDM Membrane on Rigid Insul on Metal Deck.ifc	Roofs	
Exterior Canopy.ifc	Roofs	
Live Roof over Wood Joist Flat Roof.ifc	Roofs	
Standing Seam Metal Roof.ifc	Roofs	
Residential - 200mm Max Riser 250mm Tread.ifc	Stairs	
Concrete Pan - 180mm Max Riser 280mm Tread.ifc	Stairs	
M_Skylight.ifc	Window	Roof hosted
M_Centrifugal Fan - Rooftop - Upblast.ifc	Mech. Equip.	Roof hosted
M_Roof Hatch.ifc	Doors	Roof hosted

Unless this issue can be resolved with the BimServices application developer, the IFC files for the building models will need to be created without the above object types. The objects can still be included in the Revit model for the sake of completing the building model, but they will be turned off prior to exporting the building to IFC.

9 Common Object Library IFC Files

The common object library is developed in Revit 2011 using native software elements. These objects were then exported to IFC, including both geometry and data properties. While the objects can be exported to IFC format as a common data exchange format to be loaded into other design software, some of the object functionality specific to the software may not be available after the import. For example, Revit's native ability to parametrically control the width of a door opening is not available if the door was imported from an IFC file. Other software products may have similar limitations when working with imported elements.

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14. ABSTRACT
For Building Information Modeling (BIM) technology to be successful, it must be consistently applied across many projects, by many teams. The National Building Information Model Standard–United States (NBIMS-US) has begun to deliver standards that allow teams to consistently deliver open-standard building information. The contents of this standard describe the format and quality of information to be delivered. Software configuration guides and object templates can assist users of BIM technology to more easily meet both the format and quality requirement of NBIMS-US.

The purpose of this report is to define the requirements for and document the creation of a library of building components. The components included in this report reflect the contents of common BIM models for a duplex apartment, office building, and medical clinic building that have been previously published. This common object library description may serve as a reference for those implementing national BIM standards and for future research projects.

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